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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
09/836,464	04/18/2001	Hui Chun Liu	11258-01 US	8863

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EXAMINER	
LEE, SHUN K	

ART UNIT	PAPER NUMBER
2878	

DATE MAILED: 09/20/2004

Please find below and/or attached an Office communication concerning this application or proceeding.

Office Action Summary	Application No.	Applicant(s)	
	09/836,464	LIU, HUI CHUN	
	Examiner	Art Unit	
	Shun Lee	2878	

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☒ Responsive to communication(s) filed on *16 July 2004*.

2a)☐ This action is **FINAL**. 2b)☒ This action is non-final.

3)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

4)☒ Claim(s) *1-7 and 9-24* is/are pending in the application.

4a) Of the above claim(s) _____ is/are withdrawn from consideration.

5)☐ Claim(s) _____ is/are allowed.

6)☒ Claim(s) *1-7 and 9-24* is/are rejected.

7)☐ Claim(s) _____ is/are objected to.

8)☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

9)☐ The specification is objected to by the Examiner.

10)☒ The drawing(s) filed on *09 February 2004* is/are: a)☒ accepted or b)☐ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).

11)☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

Priority under 35 U.S.C. § 119

12)☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

a)☐ All b)☐ Some * c)☐ None of:

1.☐ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____.

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

1) ☐ Notice of References Cited (PTO-892)
2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
3) ☐ Information Disclosure Statement(s) (PTO-1449 or PTO/SB/08) Paper No(s)/Mail Date _____.
4) ☐ Interview Summary (PTO-413) Paper No(s)/Mail Date. _____.
5) ☐ Notice of Informal Patent Application (PTO-152)
6) ☐ Other: _____.

DETAILED ACTION

Continued Examination Under 37 CFR 1.114

1. A request for continued examination under 37 CFR 1.114, including the fee set forth in 37 CFR 1.17(e), was filed in this application after final rejection. Since this application is eligible for continued examination under 37 CFR 1.114, and the fee set forth in 37 CFR 1.17(e) has been timely paid, the finality of the previous Office action has been withdrawn pursuant to 37 CFR 1.114. Applicant's submission filed on 16 July 2004 has been entered.

Claim Objections

2. Claim 4 is objected to because of the following informalities: "dopant concentration" on line 2 in claim 4 should probably be --doping density-- (see "doping density" on line 3 in claim 1). Appropriate correction is required.

Claim Rejections - 35 USC § 103

3. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

> (a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

4. Claims 1-5, 9-11, 21 and 23 are rejected under 35 U.S.C. 103(a) as being unpatentable over Delacourt *et al.* (US 5,160,991) in view of Liu (Semiconductor and Semimetals, Vol. 62, pg. 129-196, 1999).

In regard to claims **1-5**, Delacourt *et al.* disclose (Fig. 3) a quantum well infrared photodetector comprising:

(a) a plurality of quantum well layers (see 2 in Fig. 1) formed of a first semiconductor material (*e.g.*, GaAs; column 8, line 62 to column 9, line 2) and n-type doped forming a multi-quantum well structure for providing high absorption (*i.e.*, systematically absorbed without saturation of the detection; column 3, lines 41-45) at temperatures other than low temperatures (*e.g.*, ambient temperature at or near room temperature such as T = 300K; column 4, lines 40-44) and a substantial dark current is inherent in a quantum well infrared photodetector at temperatures other than low temperatures, wherein the plurality of doped quantum well layers (see 44 in Fig. 7) includes more than 10 quantum well layers (*e.g.*, 50 wells; column 8, lines 62-66);

(b) a plurality of barrier layers (see 1 and 3 in Fig. 1) alternating with the doped quantum well layers (see 2 in Fig. 1) formed of a second semiconductor material (*e.g.*, $Al_{0.15}Ga_{0.85}As$; column 8, line 62 to column 9, line 2); and

(c) contact layers (11, 13) for receiving current from the plurality of quantum well layers (see 2 in Fig. 1).

The photodetector of Delacourt *et al.* lacks that the doping density $Nd = (m/\pi\hbar^2)(2k_BT)$ of the first semiconductor material (*i.e.*, GaAs) is in the range of 1-2 x 10^{12} cm^{-2}, where m is the effective mass, $\hbar$ is the Planck constant, k_B is the Boltzmann constant, and T is the desired operating in degrees K. Liu teaches (third paragraph on pg. 168) that the doping density $Nd = (m/\pi\hbar^2)(2k_BT)$ of the first semiconductor material (*i.e.*, GaAs) is in the range of 1-2 x 10^{12} cm^{-2}, where m is the effective mass, $\hbar$ is the Planck constant, k_B is the Boltzmann constant, and T is the desired operating in degrees K such as room

temperature in order to maximize the detector limited detectivity. Therefore it would have been obvious to one having ordinary skill in the art at the time of the invention to provide a doping density (*e.g.*, $Nd = (m/\pi\hbar^2)(2k_BT) = (0.067 \cdot 9.1095 \times 10^{-31}\ kg/(3.1415 \cdot 1.0546 \times 10^{-34}\ Js))(2 \cdot 1.3806 \times 10^{-23}\ J/K \cdot 300K) = 1.4 \times 10^{12}\ cm^{-2}$) in the photodetector of Delacourt *et al.*, in order to maximize the detector limited detectivity.

In regard to claims **9-11**, Delacourt *et al.* in view of Liu is applied as in claims 1-5 above. The photodetector of Delacourt *et al.* lacks an explicit description that the contact layers comprise a third doped semiconductor material. However, Delacourt *et al.* also disclose embodiments including a contact layer (13) formed by a third doped semiconductor (*e.g.*, 1×10^{17} - $5 \times 10^{18}\ cm^{-3}$ n doped GaAs; column 8, line 62 to column 9, line 2) in order to obtain an ohmic contact (column 5, lines 26-28). Therefore it would have been obvious to one having ordinary skill in the art at the time of the invention to provide a third doped semiconductor as the contact layers in the photodetector of Delacourt *et al.*, in order to obtain ohmic contacts.

It is noted that cryogenic cooling is defined as temperatures <150K in the specification (pg. 4, line 15). In regard to claims **21** and **23** (which are dependent on claim 4), Delacourt *et al.* also disclose a method of detecting infrared radiation comprising the steps of:

(a) detecting infrared radiation (column 1, line 48 to column 2, line 28) with a quantum well device absent cryogenic cooling (*e.g.*, ambient temperature at or near room temperature such as T = 300K; column 4, lines 40-44); and

(b) determining an intensity of the detected infrared radiation (column 7, lines 58-59).

5. Claims 6, 7, 12-17, and 24 are rejected under 35 U.S.C. 103(a) as being unpatentable over Delacourt *et al.* (US 5,160,991) in view of Liu (Semiconductor and Semimetals, Vol. 62, pg. 129-196, 1999) as applied to claims 5 and 11 above, and further in view of Sato *et al.* (US 5,077,593).

In regard to claims **6** and **7** (which are dependent on claim 5) and claim **12** (which is dependent on claim 11), Delacourt *et al.* is applied as in claims 9-11 above. The modified photodetector of Delacourt *et al.* lacks that the n-type dopant is Si. However, N-type doping for GaAs is well known in the art. For example, Sato *et al.* teach (column 5, lines 39-44) that n-type doping for GaAs comprises Ge, S, Si, Sn, Te, or Se. Therefore it would have been obvious to one having ordinary skill in the art at the time of the invention that the n-type doping in the modified photodetector of Delacourt *et al.* comprise a known n-type doping such as Si.

In regard to claim **13** which is dependent on claim 12, Liu is applied as claims 4-6 above.

In regard to claims **14-15** which are dependent on claim 13, Delacourt *et al.* also disclose that the Al fraction of the second semiconductor material (*i.e.*, $Al_{0.15}Ga_{0.85}As$; column 8, line 62 to column 9, line 2) is 10%-50%.

In regard to claims **16** and **17** which are dependent on claim 15, Sato *et al.* is applied as claims 6 and 7 above.

In regard to claim **24**, Delacourt *et al.* in view of Liu is applied as in claims 1-5 above and Sato *et al.* is applied as in claims 6 and 7 above.

6. Claims 18-20 are rejected under 35 U.S.C. 103(a) as being unpatentable over Delacourt *et al.* (US 5,160,991) in view of Liu (Semiconductor and Semimetals, Vol. 62, pg. 129-196, 1999) and Sato *et al.* (US 5,077,593) as applied to claim 17 above, and further in view of Wen *et al.* (US 5,352,904) and Brouns (US 5,773,831).

In regard to claim **18** which is dependent on claim 17, the modified photodetector of Delacourt *et al.* lacks that the third doped semiconductor material is 0.1-2 μm thick. However, contact layers are well known in the art. For example, Wen *et al.* teach (column 4, lines 51-58) that the contact layer thickness should be selected to limit the electron energy loss (*e.g.*, 0.1 to 0.15 μm thick GaAs). As another example, Brouns teaches (column 3, lines 27-30) that a 0.15 μm thick n-type doped GaAs contact layer is transparent to infrared radiation. Therefore it would have been obvious to one having ordinary skill in the art at the time of the invention to provide 0.15 μm thick n-type doped GaAs layers as the contact layers in the photodetector of Delacourt *et al.*, in order to obtain infrared radiation transparent contact layers that also minimize electron energy loss.

In regard to claims **19** and **20** which are dependent on claim 18, the modified photodetector of Delacourt *et al.* lacks an explicit description that the plurality of doped quantum well layers is designed for operation at frequencies above 1 GHz or 30 GHz. However, the physical characteristics of GaAs/AlGaAs are well known in the art. For example, Liu teach (pg. 176-182) that operational frequencies depend on the carrier lifetime. Therefore it would have been obvious to one having ordinary skill in the art at

the time of the invention that the modified photodetector of Delacourt *et al.* is operational at high frequencies (*e.g.*, 30 GHz).

7. Claim 22 is rejected under 35 U.S.C. 103(a) as being unpatentable over Delacourt *et al.* (US 5,160,991) in view of Liu (Semiconductor and Semimetals, Vol. 62, pg. 129-196, 1999) as applied to claim 21 above, and further in view of Choi (US 5,384,469).

In regard to claim **22** which is dependent on claim 21, the modified method of Delacourt *et al.* lacks that the step of determining comprises the step of filtering the dark current component of the detected signal to determine an intensity of the detected infrared radiation. Choi teaches (column 7, lines 8-27) filtering the dark current component of the detected signal in order to detect the infrared radiation intensity with more sensitivity. Therefore it would have been obvious to one having ordinary skill in the art at the time of the invention to filter the dark current in the modified method of Delacourt *et al.*, in order to detect the infrared radiation intensity with more sensitivity.

Conclusion

8. Any inquiry concerning this communication or earlier communications from the examiner should be directed to Shun Lee whose telephone number is (571) 272-2439. The examiner can normally be reached on Monday-Thursday.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, David Porta can be reached on (571) 272-2444. The fax phone number for the organization where this application or proceeding is assigned is 703-872-9306.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see http://pair-direct.uspto.gov. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free).

CONSTANTINE HANNAHER
PRIMARY EXAMINER
GROUP ART UNIT 2878

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